

DEVELOPMENT OF JELLY GUMS WITH FRUITS AND HERBS: COLOUR AND SENSORY EVALUATION

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Abstract

This work aimed to evaluate the colour and sensory properties of jelly gums made with fruits and herbs. The colour was measured by a colorimeter in the Hunter lab coordinates (L^ , a^* and b^*). Sensory evaluation comprised preference tests and profile analysis. The results showed that the colour of gums with blueberry was considerably different than other fruits (strawberry and raspberry). The sensory preference test allowed choosing 4 from the 16 prototypes developed (Blueberry & Mint, Raspberry & Mint, Strawberry & Mint, Strawberry & Anise), which were then characterized in terms of colour and sensory properties. The sensorial profile showed that Blueberry & Mint gums had visual aspect indicators as well as a better aroma to herb. However, for most of the attributes evaluated, the gums made with Strawberry & Anise got higher scores, including global appreciation. The results of colour evaluation revealed that the Blueberry & Mint gums were substantially different from the others. Hence, the results indicated that two of the gums developed, Blueberry & Mint and Strawberry & Anise, might have success when launching on commercialization.*

Keywords: *development of new food, consumer acceptance, colour, sensory analysis*

1. INTRODUCTION

Presently there is a demand for products containing natural antioxidants for their role in delaying aging processes, as well as in the prevention of degenerative diseases. Research has demonstrated that the edible berry fruits rich in antioxidants, anthocyanins, and other phenolic compounds have positive impact on human health, namely reducing the risk factors of cancer, cardiovascular diseases, obesity, diabetes, aging, urinary tract infections, tooth and gum disease (de Macêdo et al., 2017; Istek and Gurbuz, 2017).

The search for sources of dietary antioxidants has focused on small forest fruits, or red fruits, that contain large amounts of polyphenols and vitamins with antioxidant activity (Escarpa, 2012). Many small fruits, including strawberries, blueberries, and other red fruits, contain many compounds with proven benefits to enhance human health. Among them, polyphenols are of particular importance, because their chemical structure makes them able to act as antioxidants as well as antimicrobials. The antioxidant activity of polyphenols may prevent side effects of some diseases where oxidative stress is involved, such as diabetes, cardiovascular and inflammatory diseases, cancer, and metabolic syndrome alterations, among others. Flavonoids are a particularly important class of phenolic compounds, and include the compound quercetin, present in berries and grapes, which has demonstrated beneficial effects on diabetes, cancer, and metabolic diseases. Another group of polyphenols with relevance is procyanidins, which have effects on cancer prevention, and anthocyanins, such as cyanidin and delphinidin, which have antiinflammatory effects (Calderón-Oliver and Ponce-Alquicira, 2018).

The two dominant groups of phenolic compounds in raspberries are anthocyanins and ellagitannins. Among the anthocyanins, the most abundant are cyanidin glucosides, sophorosides, rutinosides and glucosyl-rutinosides as well as low to trace levels of pelargonidin derivatives. However, other anthocyanins can be found in raspberries, even though in smaller amounts: cyanidin 3-O-sambubioside and cyanidin 3-xylosyl-rutinoside. The two principal ellagitannins in raspberries include the dimeric HHDP (hexahydroxydiphenic) sanguin H-6 and a tetrameric HHDP lambertianin C, as well as small amounts of ellagic acid, which is the product of their hydrolysis. Other ellagitannins have also been reported, most notably sanguin H-10, potentilin, casuarictin, galloyl- and galloyl-bis-

HHDP-glucose, besides some ellagic acid conjugates in the form of pentosides, methyl pentosides and acetyl pentosides (Gülçin et al., 2011; Krauze-Baranowska et al., 2014; Kula et al., 2016).

Blueberries are of particular importance among fresh berry fruits owing to their high antioxidant capacity and high concentration of anthocyanins and other phenolic compounds. Blueberries are rich in anthocyanins, derived from anthocyanidins (delphinidin, cyanidin, petunidin, peonidin, and malvidin), which were connected with galactose, glucose and arabinose. Blueberries are a good source of chlorogenic acid, quercetin, kaempferol, myricetin, proanthocyanidins, catechin, epicatechin, resveratrol, besides vitamin C, all contributing for the high antioxidant activity (Istek and Gurbuz, 2017; Wu et al., 2017).

Phenolic compounds in blackberries include anthocyanins, like cyanidin derivatives, and flavonols, being the most frequent quercetin, myricetin, and kaempferol. The phenolic acids, such as hydroxybenzoic and hydroxycinnamic acids and free ellagitannins have also been identified in several blackberry species (Kaume et al., 2012; Kim et al., 2015).

Phenolic compounds in strawberry were identified as belonging to the main group of flavonoids (anthocyanins, flavanols, flavonols), phenolic acids (hydroxycinnamic acids) and hydrolysable tannins (ellagitannins) (Giampieri et al., 2012; Guerrero-Chavez et al., 2015).

The objective of this work was to develop healthy jelly gums made with fruits and herbs. Furthermore, and because consumer acceptance is pivotal in food development, a sensory evaluation was accomplished and evaluation of colour was also performed, to allow inferring the possible acceptance of this innovative product.

2. MATERIAL AND METHODS

2.1. Samples Development

With regard to experimental development, it took 7 formulations, on an iterative process, exploring different possibilities and evaluating the outcomes, until the desired product was obtained. In the beginning the objective was to test the viability of conjugation of red fruits with aromatic herbs. As the product was could not gain consistency only with red fruits, herbs and pectin, it was decided in the beginning to use apple as a basis in all gums, because it helps obtaining a desired consistency.

Several jelly gums were tested, in which four fruits (raspberry, blueberry, strawberry and blackberry) would be conjugated with four aromatic herbs (parsley, camomile, anise and mint). All gums were made with fresh fruits and dries aromatic herbs.

The 1st attempt was to connect some ingredients with pectin, to test if the gums gained consistency. When the first test was made, it was verified that the gums were not gaining consistency and they were losing water, due to the high water content in the fruits. Therefore, only two fruits (strawberry and blueberry) could be used in this stage to produce gums, which were left in the refrigerator until solidification.

The 2nd trial attempted to improve the gums in terms of consistency. For that, the gums were placed in a dehydrator to promote moisture loss and hardening. However, the results were also not very positive, although the flavours obtained were pleasant. After this, the right consistency was not yet right, and only one gum was more or less successful (strawberry with camomile).

In the 3rd attempt it was decided to increase the amount of pectin, to see if the gum gained more consistency. They were dehydrated at an increased temperature and the loss of water was more significant, but the gums looked somewhat burned. The strawberry with parsley gums resulted better.

On the 4th attempt, it was decided to test another gelling agent, agar-agar, since the pectin alone proved it was not working. Duplicates of all gums were made, one version with pectin only and one with agar-agar alone. It was also decided to take the gums alone to the refrigerator. The most satisfactory final result in relation to the consistency was the gums that contained agar-agar, because this gelling agent is much stronger than pectin. It was also noticed that the gums did not need dehydration, because the

effect of cold in the refrigerator would be enough to gain consistency. Although consistency improved, the products were still not satisfying in terms of global characteristics.

On the 5th attempt, it was decided to add pectin and agar-agar combined and in increased amounts. This test allowed obtaining gums with perfect texture, however, the form tested was not desirable, since they were not uniform or moulded (Figure 1).



Figure 1. Strawberry & camomile jelly gum.

In the 6th attempt it was decided to make the gums in cuvettes, to form uniform gums in terms of shape and size. However, the result was not as expected, since the gums were not gaining consistency and were trapped in the cuvettes.

Further experiments were then carried out until it was concluded that the proportions of pectin and agar needed to be adjusted. The 7th and last attempt allowed obtaining the desirable gums.

The formulation of the 16 gums produced is presented in more detail in Table 1. In general all the gums were pleasant, both in terms of flavour and consistency. Visibly the most beautiful gums were those that contained anise, since the appearance was smooth, while in the other gums which incorporated other types of aromatic herbs, the texture was less smooth (Figure 2). The flavour was characteristic of each of the aromatic herbs used, and the gums that contained mint were cooler, while the aniseed gums were sweeter.

Table 1. Quantities of the ingredients used in the gum's formulations.

Ingredients	Strawberry Gums	Raspberry Gums	Blueberry Gums	Blackberry Gums
Apple puree (g)	80	80	80	80
Berries (g)	67	59	65	57
Pectin (g)	11	11	11	11
Agar-agar (g)	8	8	8	8
Aromatic herbs (g) <i>Camomile / Anise / Mint / Parsley</i>	10	10	10	10



Figure 2. Strawberry & Anise jelly gums (left) and Blueberry & Parsley jelly gums (right).

2.2. Sensory Evaluation

The sensory evaluation consisted in two tests: a proof of preference and definition of the sensorial profile. For the proof of preference, the sixteen samples of four different red fruit gums with four different aromatic herbs were used. These were duly identified with a 3-digit code to facilitate the test by keeping samples uncharacterized for the taster. The panellist had to classify each sample on a continuous scale with 10 cm, going from 0 (do not like) to 10 (like very much).

Of the 16 gums, the 4 identified as preferred by the panel members, were further subject to sensorial profile analysis for characterization. The four samples, duly identified, were presented to each taster to analyse the descriptive level of each sample separately. The attributes evaluated were 3 for visual aspect (colour, homogeneity, and general aspect), 2 for aroma (aroma to fruit and to herb), 4 for taste (bitter, sweet, to fruit, to herbs), 3 for texture (consistency, elasticity, roughness), and finally global appreciation. For all attributes a 5 point Hedonic scale was used ranging from 1 (least intense) to 5 (most intense).

The panel was composed of fifteen tasters.

2.3. Colour Measurement

Colour can be measured using the CIELAB coordinate system defined by the *Commission Internationale de L'éclairage - 1976*. The CIE L^* , a^* and b^* were assessed using a portable colorimeter Chroma Meter CR-400 from Konica Minolta. The coordinate L^* corresponds to lightness, ranging from 0 (black) to 100 (white), and a^* and b^* are opposing colours coordinates: a^* goes from -60 (green) to +60 (red) and the coordinate b^* varies from -60 (blue) to +60 (yellow) (Barroca et al., 2013). For the evaluation of colour were made measurements on the top and on the bottom faces of 20 gums of each variety.

The colour can be further converted into the cylindrical coordinates, which comprise the value, hue angle (h°) and chroma (C) or colour saturation. For the conversion the equations described below can be used (Barros, 2011):

$$Value = \frac{L^*}{10} \quad (1)$$

$$\begin{cases} h^\circ = \tan^{-1}(b^*/a^*), \text{ for } a^* > 0; b^* > 0 \\ h^\circ = 180^\circ + \tan^{-1}(b^*/a^*), \text{ for } a^* < 0; b^* > 0 \\ h^\circ = 270^\circ + \tan^{-1}(b^*/a^*), \text{ for } a^* < 0; b^* < 0 \\ \begin{cases} C = \sqrt{a^{*2} + b^{*2}} \\ h^\circ = 360^\circ + \tan^{-1}(b^*/a^*), \text{ for } a^* > 0; b^* < 0 \end{cases} \end{cases} \quad (2)$$

$$(3)$$

The hue angle (h°) differentiates between green, blue, yellow or red (Figure 3). This perception of colour outcomes from alterations in the absorption of radiation according to the wavelength. The coordinate chroma, also designated as saturation or purity, shows how much the colour is different from grey, and hence it differentiates the bright from the dim colours.

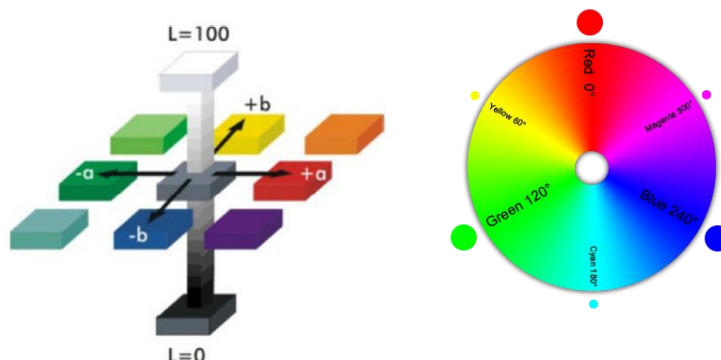


Figure 3. Hunter Lab colour space (a) and hue angle (b).

3. RESULTS AND DISCUSSION

3.1. Sensorial analyses

3.1.1. Preference test

Table 2 presents the mean scores and corresponding standard deviation obtained for the 16 samples of jelly gums with small fruits and aromatic herbs developed. The scores vary from a minimum value of 0 to a maximum of 10. The highest values are around 5, which signifies that these prototypes are not yet very much appreciated by the panellists.

Table 2. Mean scores of the 16 different gums developed obtained in the preference test.

Jelly gums	Mean Score ¹	Standard Deviation
Strawberry & Anise	4.70	1.82
Strawberry & Camomile	4.05	2.30
Strawberry & Mint	5.28	2.29
Strawberry & Parsley	3.19	1.77
Blackberry & Anise	4.19	1.92
Blackberry & Camomile	3.01	2.07
Blackberry & Mint	4.63	2.08
Blackberry & Parsley	2.80	2.41
Raspberry & Anise	4.19	2.62
Raspberry & Camomile	3.19	2.50
Raspberry & Mint	5.21	2.73
Raspberry & Parsley	3.12	2.26
Blueberry & Anise	4.08	2.37
Blueberry & Camomile	2.99	2.31
Blueberry & Mint	4.80	2.36
Blueberry & Parsley	2.81	2.16

¹Measurement scale from 0 to 10.

The 4 gums with highest mean score in the preference test were identified as Strawberry & Anise, Strawberry & Mint, Raspberry & Mint, Blueberry & Mint, including almost all of the fruits tested, just excluding the blackberry. Besides, for all of the fruits, the best combination was mint flavour, followed by anise in the case of combination with strawberry. These 4 selected varieties were further used in the continuation of this work, being characterized in terms of sensorial profile, colour and nutritional composition.

3.1.2. Sensorial profile

Figure 4 shows the sensorial characteristics of the 4 gums selected, in terms of visual aspect (colour, homogeneity, and general aspect), aroma (aroma to fruit and to herb), texture (consistency, elasticity, roughness), taste (bitter, sweet, to fruit, to herbs) and finally global appreciation. For all attributes a 5 point Hedonic scale was used ranging from 1 (least intense) to 5 (most intense).

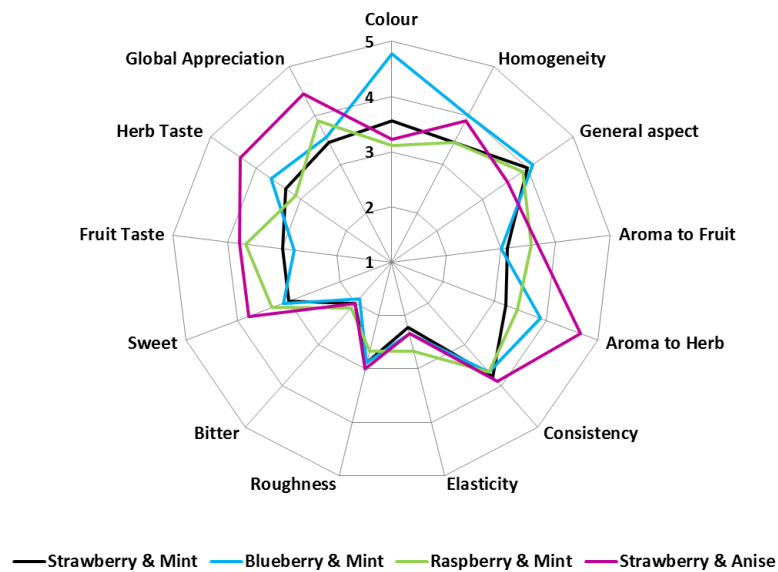


Figure 4. Sensorial profile of the 4 selected jelly gums.

The results in Figure 4 show that Blueberry & Mint gums have better visual aspect indicators (colour, homogeneity, and general aspect), as well as the aroma to herb. For all other characteristics, the sample Strawberry & Anise obtained higher results, only with the exception of elasticity, which was higher for the raspberry & mint gum. These results, and also considering the scores for global appreciation, indicated that Strawberry & Anise gums was much more valued by the tasters, with a mean score for global appreciation of 4.44, which is high considering the measurement scale varying from 1 to 5.

3.2. Colour

Figure 5 presents the values obtained for lightness (L^*) in the top and bottom faces of the 4 selected gums. The results indicate that the blueberry gums are much darker, with lower values of lightness, when compared to the other gums, with very similar values of L^* , which is relatively expected since they include strawberry or raspberry, which are similar in terms of colour. Furthermore, the results showed that the bottom face was slightly lighter when compared with the top part of the gums.

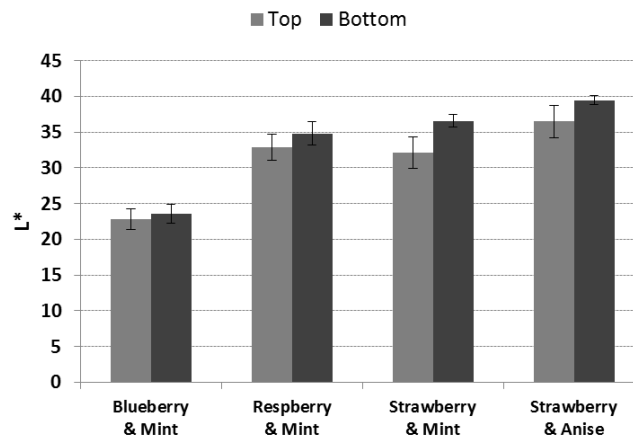


Figure 5. Lightness (L^*) of the 4 selected gums analysed.

The results for the colour coordinate a^* , representing redness for positive values, are shown in Figure 6 and they indicate that the Strawberry & Mint gums were less red when compared with the other samples, where the intensity of redness was higher. The redness was more intense in the bottom faces when compared with the top faces.

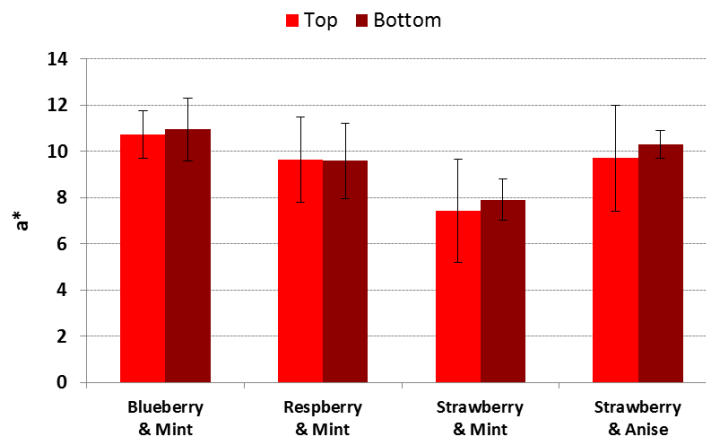


Figure 6. Redness (a^*) of the 4 selected gums analysed.

Figure 7 presents the intensity of the yellow coloration (for the positive values of b^*) or blueness (when b^* is negative, like in the case of the Blueberry & Mint gums). The intensity of yellow coloration is high for the gums containing raspberry and strawberry, being in general more intense on the bottom face. On the contrary, for the gums containing blueberry, the intensity of the blue coloration is weak, with low absolute values (less than 1).

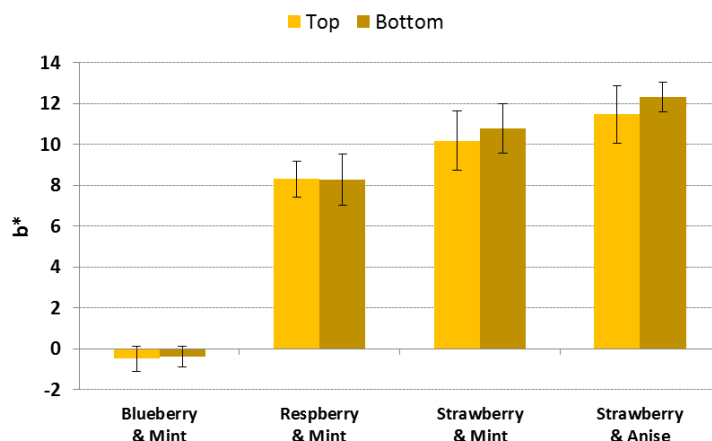


Figure 7. Blueness/yellowness (b*) of the 4 selected gums analysed.

Table 3 shows the cylindrical coordinates of the 4 samples at study, and the results point out that most of the samples stand near the 45° area for hue°, which is the border between red and pink. The exception is sample Blueberry & Mint, with value near 360°, which is red (also 0°). The values of chroma indicate colour saturation and these samples show good saturation, meaning that the colour are somehow intense.

Table 3. Cylindrical coordinates (calculated mean values) for the 4 selected jelly gums.

Jelly gums	Value		Hue		Chroma	
	Top	Bottom	Top	Bottom	Top	Bottom
Blueberry & Mint	2.283	2.358	357.333	357.911	10.747	10.957
Raspberry & Mint	3.288	3.478	40.727	40.788	12.717	12.659
Strawberry & Mint	3.213	3.657	53.930	53.783	12.592	13.375
Strawberry & Anise	3.648	3.948	49.744	50.140	15.015	16.054

4. CONCLUSIONS

The present work allowed concluding that from 16 types of jelly gums with small fruits and aromatic herbs tested four of them have potential for commercialization: Blueberry & Mint, Raspberry & Mint, Strawberry & Mint, Strawberry & Anise.

The results of the sensorial profile indicate that Blueberry & Mint gums show better visual aspect indicators (colour, homogeneity, and general aspect), besides a better aroma to herb. However, for most of the other characteristics, the gums made with Strawberry & Anise obtained higher results, including for global appreciation, with a mean score of 4.44, being close to the maximum value of the scale considered, which was 5.

The results of colour evaluation revealed that the Blueberry & Mint gums were those more different, with lower values of L* and negative values of b*, against all other sample which had positive values of b*.

In general, the results indicated that these four gums have potential for commercialization, and particularly the 2 varieties more valued by the sensory tasters, which were Blueberry & Mint and Strawberry & Anise.

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